Optimising SARS-CoV-2 pooled testing for low-resource settings

Several policy proposals to suppress severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) have been supporting mass individual testing in the USA and other countries.[1–3] With restricted testing capacity, such testing is not only infeasible for low-income countries, but also an inefficient use of scarce testing kits that adversely affects the global supply of testing kits.

Group testing offers a viable alternative.[4,5] The idea of this approach is to test samples drawn from multiple people at the same time. If the test is negative, everyone in the group is considered negative; if it returns positive, then at least one individual is infected with SARS-CoV-2. Here we discuss three different approaches to group testing that are benchmarked against individual testing. Approach 1 discusses prevalence estimation, and approaches 2 and 3 discuss strategies to relax lockdowns with maximum laboratory capacities of pooling 64 (approach 2) and ten samples (approach 3).

Approach 1 estimates the prevalence of SARS-CoV-2. Let us compare two methods: individual testing, in which a sample of *N* people (eg, 220 million) are tested for the virus, and group testing, in which *G* groups of *n* individuals are tested. A simple approach is to do one-time pooled sampling to identify negative and positive clusters. Given a prevalence of *p* we can calculate *n*.[6] However, we assume the maximum value of *n* to be 64 or fewer on the basis of a recent laboratory-based study in Israel.[7] Notably, for prevalence estimation, the SARS-CoV-2 status of individuals does not need to be verified, which saves on tests.

For a prevalence of 1% or lower, where *n* is 64 and G is 3·44 million, 3·44 million tests will be needed. Thus, group testing is 64:1 more efficient than individual testing. Even when prevalence increases (eg, *p*=10%), we can still see that group testing requires fewer tests than individual testing. Under this scenario, the group size *n* (a plot of *n* against *p* is shown in the appendix [p 1]) can be thought of a measure of relative efficiency of group testing over individual testing in terms of tests needed; even pooling ten swabs will be ten times more efficient than individual testing.

Nearly three billion people worldwide have been in lockdown since the beginning of the SARS-CoV-2 epidemic, but since the beginning of May, 2020, there has been a push towards relaxing lockdowns.[8] Consider instead the household as a basic unit of analysis. If one person is affected by SARS-CoV-2, the risk of infection among household members is likely to be very high.[9,10] In approach 2, the size of the group to be tested is determined to maximise the number of households whose testing shows they are not infected. This approach will allow low-income countries to send healthy people back to work as soon as possible, jointly addressing concerns regarding increased hunger and disease. Such an approach yields *n* to be the inverse of *p*.[6] Similar to approach 1, we assume maximum *n* to be 64 or fewer. If *p* is 1%, 34·12 million households will be divided among 0·53 million groups of 64 individuals, and 0·53 million tests will be required compared with 220 million needed under an individual-testing approach. Approach 2 is even more efficient than approach 1 for a wide range of prevalences (appendix p 1).

In practice, approach 2 could be implemented in various ways. For instance, we could use contact tracing to divide a country into susceptible groups (*S*), and non-susceptible groups (NS). In that case, we can redo the optimisation so that for *S*, with a higher *p*, *n* will be smaller and *G* will be larger, and for NS, with a lower *p*, *n* will be larger and *G* will be smaller. Hence, an area with a prevalence of 0·5% or less can be thought of as part of an NS group, and an area with a prevalence of 10% can be thought as being part of an *S* group (appendix p 1). We can see that our approach yields a more efficient solution to test not only the NS groups, but even the *S* groups.

In approach 3, we consider that low-income counties have restricted laboratories capacities so that no more than ten tests can be pooled. Under this approach, the estimates for the relative benefit curve with restricted tests are still an order of magnitude larger (64·5:1) than that for the individual-testing approach, irrespective of testing in higher (p=10%) or lower (p=0·5%) prevalence areas (appendix p 1). Notably, pooled testing presents an efficient solution even for identifying individuals—eg, for any positive pool, one can re-test subgroups

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See Online for appendix

within any positive pools until any positive individual or individuals are identified.[6]

Group testing is not only more feasible but is a more efficient method than individual testing by several orders of magnitude, and at a time when tests are in short supply globally, is a more socially responsible strategy.

We declare no competing interests.

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